Food and Agriculture Organization of the United Nations

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
iotc ctoi

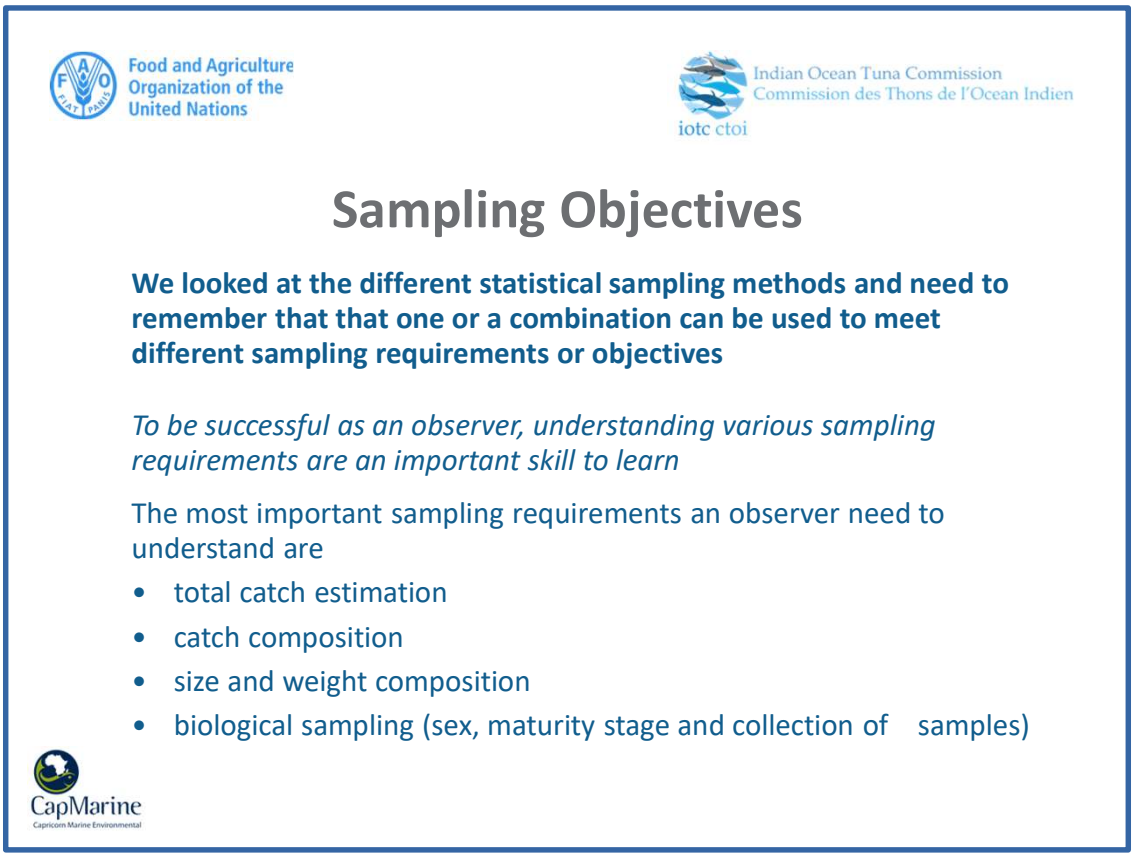
Sample selection strategies

IOTC ROS SFO TR11

Category: Sampling methods and strategies

IOTC ROS SFO TR11

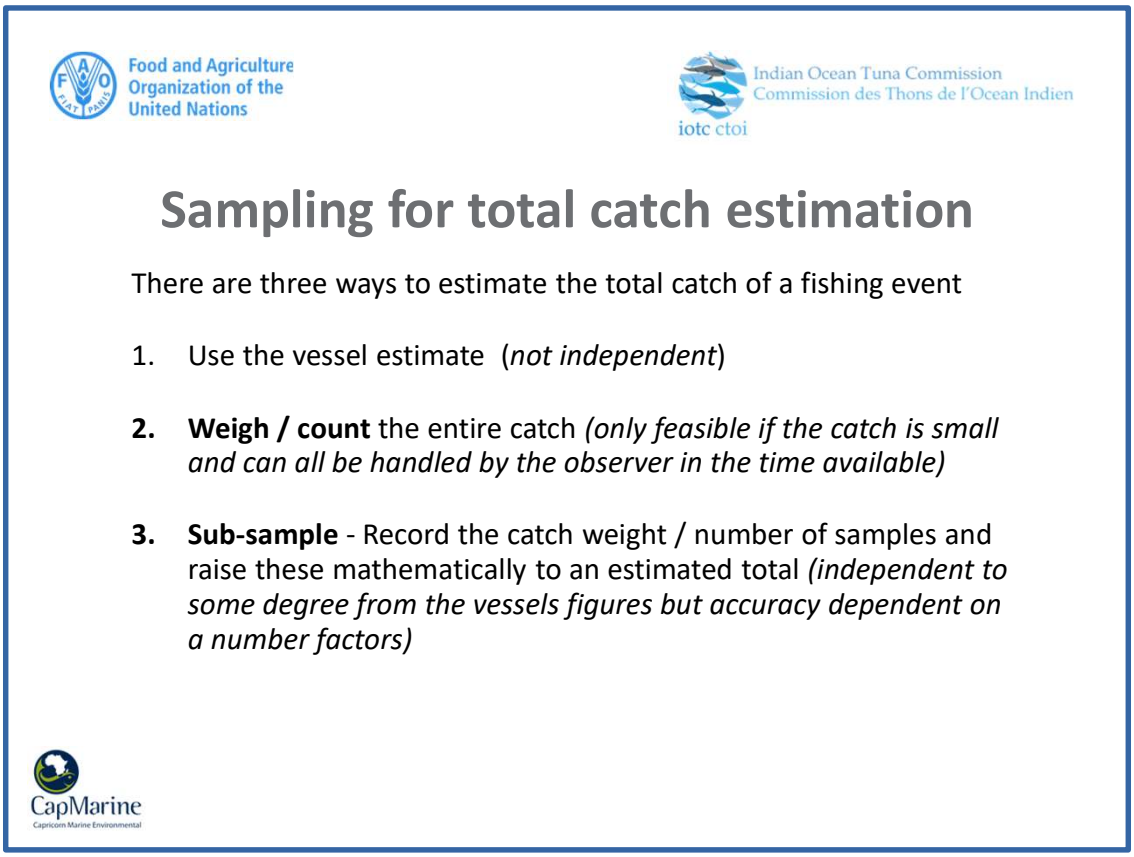
CapMarine
Capricorn Marine Environmental



We noted in the previous presentation that different statistical sampling methods can be used to meet the various sampling requirements or objectives of which the most basic are:

- total catch estimates
- catch composition;
- by-catches and discarded catch; and
- biometrics of catch and by-catch that can include length and weight, sex and maturity and any other specific aspects that make be required for special studies on specific species. These would typically include collecting DNA samples or information on diet

Broadly we look at sampling strategies for each of these objectives to represent the characteristics of the entire catch, and this requires some degree of random selection within each of the strategies used. However, in some cases, especially where biometrics, samples are selected to meet specific requirements other strategies can be followed.

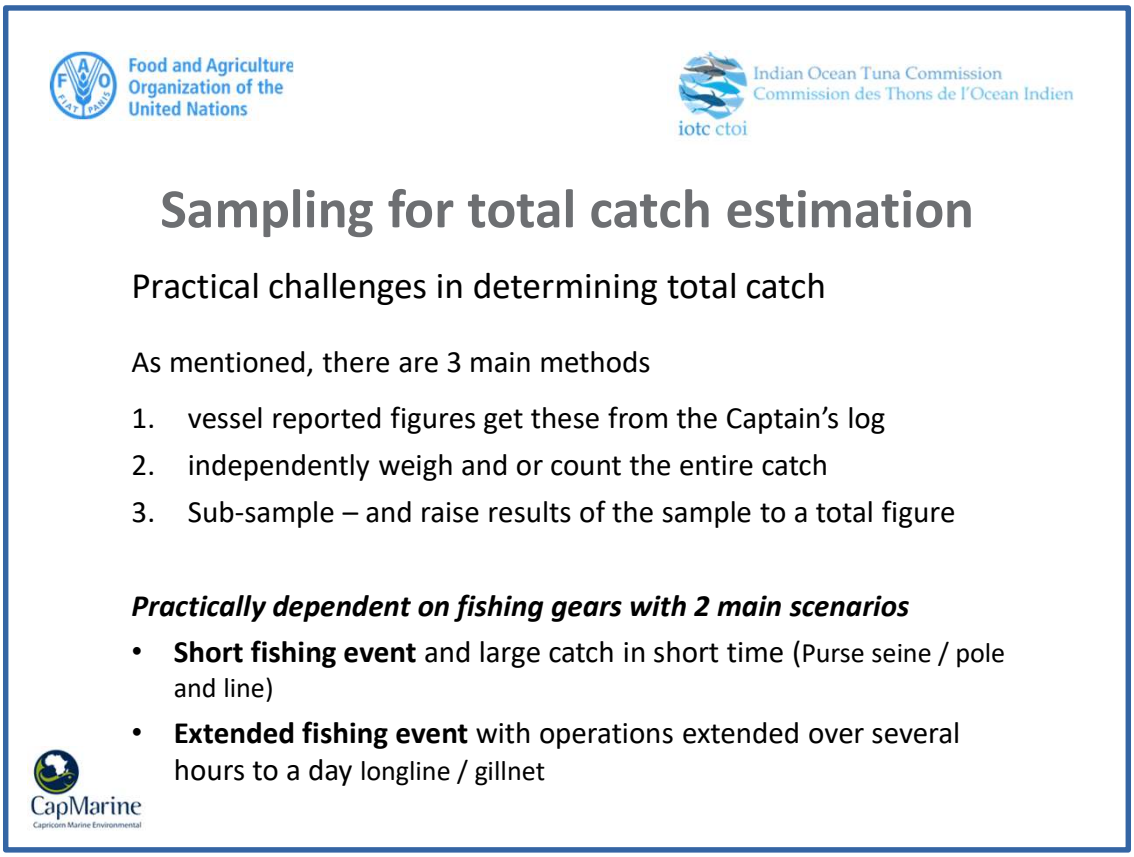


One of the fisheries scientists' primary functions in managing a fishery is to determine the size of a population and calculate how much can be harvested without causing the population to collapse, i.e. they try to calculate a sustainable yield. One of the main factors, they require to do this, is data on total catches (weight and number), of fish removed from the population.

This information is in part, provided by the vessels catch records submitted as part of their licence requirements, but often, only include the retained catches and not the discarded component or details on other by-catch species. Therefore, one of the main functions of an observer is to collect accurate and independent data on total catches.

Other than recording the vessels estimation of the catch there are several sampling methods used to calculate total catch, of which the main two are:

- exhaustive sampling by weighing and or counting all the fish caught, (the total catch); and
- proportional sampling, raising the figures to the total catch.



Practical challenges in determining total catch

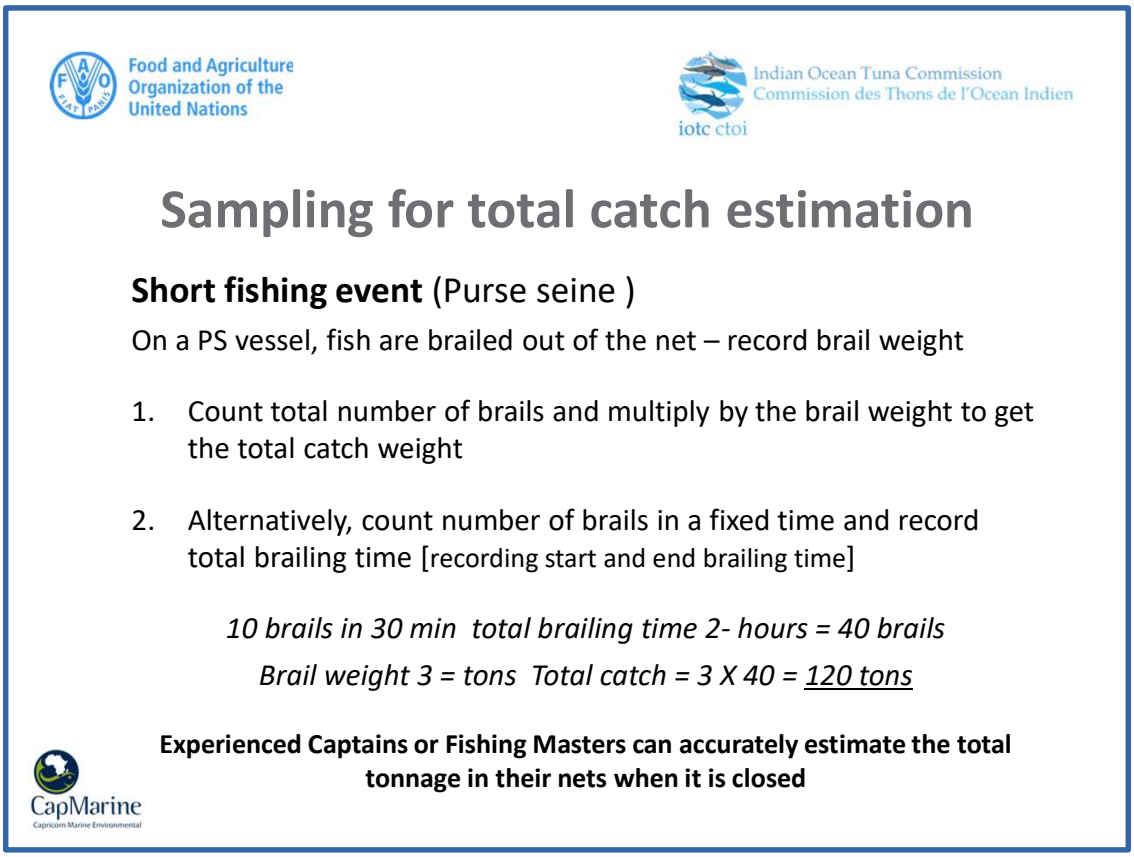
As mentioned earlier, there are 3 main methods:

1. vessel reported figures get these from the Captain's log
2. independently weigh and or count the entire catch
3. Sub-sample – and raise results of the sample to a total figure

Each of these have their own advantages and disadvantages and the method uses is dependant mainly on fishing method and how the catch is handled.

Practically the sampling will be dependent on the fishing gear with 2 main scenarios

1. Short fishing event and large catch in short time (Purse seine / pole and line) where over 100 tonnes can be caught within an hour.
2. Extended fishing event with catch extended over several hours to a day (longline / gillnet). A longline or gillnet can be set from 10 to over 100 km and take over a day to retrieve. *Catches are generally less than purse seine or pole & Line and the catch rate can be spread over the entire day.*



On a purse seine vessel, the fish are brailed out of the net and each brail has a relatively constant weight that can be provided by the vessel from experience or can be determined by weighing using a hook scale that can weigh up to 5-tonnes.

The number of brails can either be counted in totality, and the brail weight then multiplied by the total number of brails to get the total catch weight.

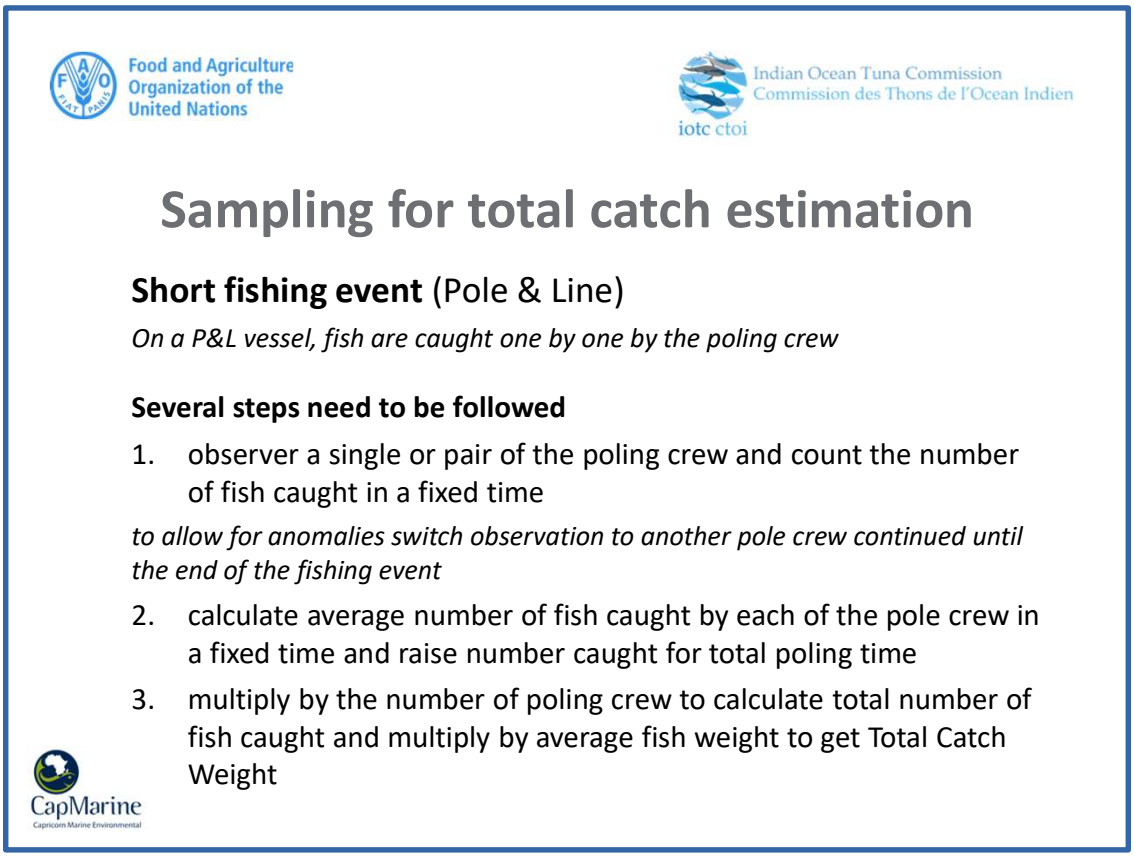
Alternatively, the number of brails in a fixed time can be determined and the total brailing time used to calculate the total number of brails [recording start and end brailing time]

For example; 10 brails in 30 min total brailing time 2 hours = 40 brails

Brail weight equals 3 = tons Total catch = 3 X 40 = 120 tons.

There are also other alternative methods used by the vessel and it is important to also record these. Experienced Captains or Fishing Masters can accurately estimate the total tonnage in their nets when it is closed.

On a purse seiner the fish are frozen in wells that have a fixed capacity (depending on the vessel size that can vary from 10 to 40 tons. After each catch the bosun or officer in charge of the well deck will record the number of wells taken up by the catch. Essentially the vessel should be able to provide an accurate total catch weight and the observers calculations serve mostly to verify these. Following the above methods, it is unlikely the observer should be more than 10% out so if there is a large difference between the observers and vessels figures it should be noted and queried.



On a P&L vessel, fish are caught one by one by the poling crew and the fish accumulate in a catchment area behind the poling crew from where they can be channelled from this area to the hold below.

If all the fish are accumulated into a catchment area for the entire fishing event the volume of the fish could be estimated depending on the dimensions of this area and determining the weigh to fish in a cubic metre.

A more practical and accepted method to follow is to

1. Observer a single or pair of the poling crew and count the number of fish they catch in a fixed time. To allow for anomalies the observation should be switched to another pole crew and this process continued until the end of the fishing event.
2. Calculating the average number of fish caught by each of the pole crew in a the observed time and raise this to the total poling time to get the total number of fish caught for the event.
3. This needs to be followed by subsampling a random selection of fish to get an average weigh. This is then multiplied by the total number caught to get a **total catch weight**

For example; Crew 1 catches 7 fish in 2 minutes

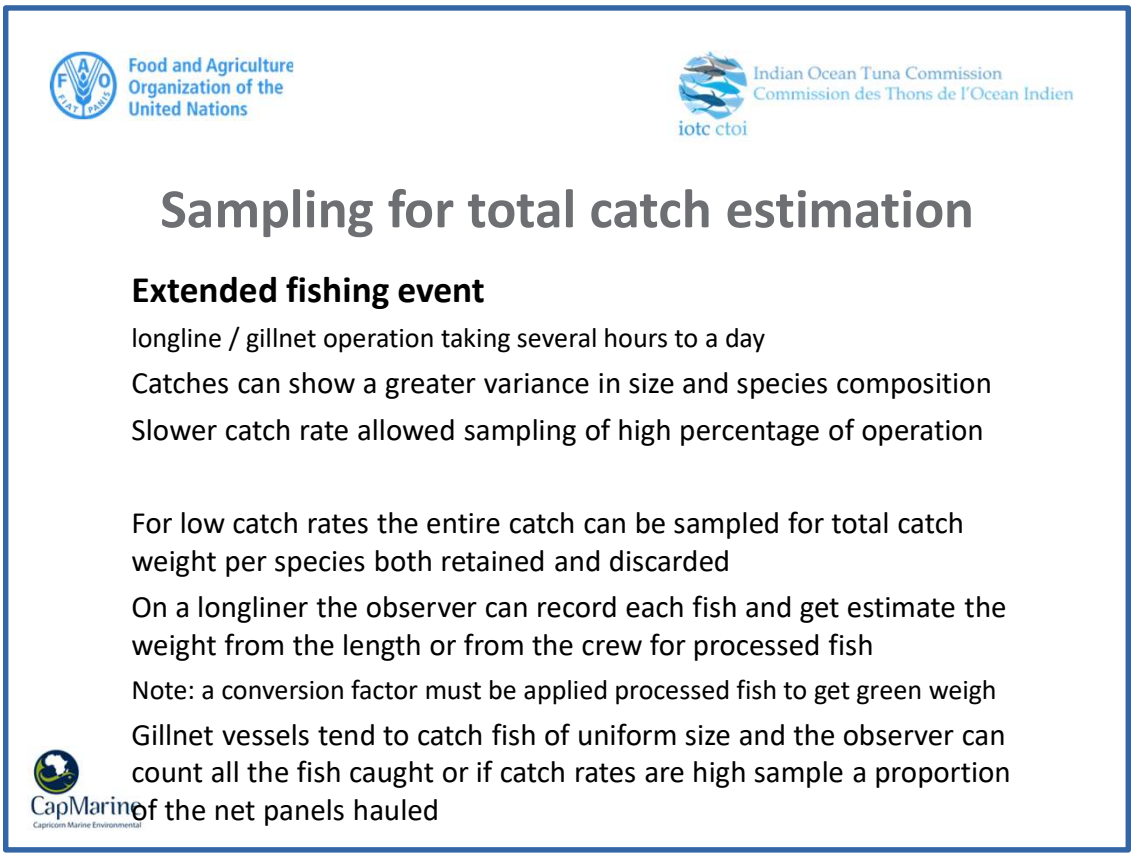
Crew 2 catches 11 fish in 2 minutes

Crew 3 catches 9 fish in 2 minutes

[7+11+9 = 27]

27 / 3 = 9 fish per crew in 2 minutes = 4.5 fish in 1 minute

Total number of poling crew = 10
Total poling time 30 minutes
Total number of fish would be 4.5 x 30 x 10 = 1350 fish
Average weight per fish = 5 kg
Total catch weight = 6750 kg



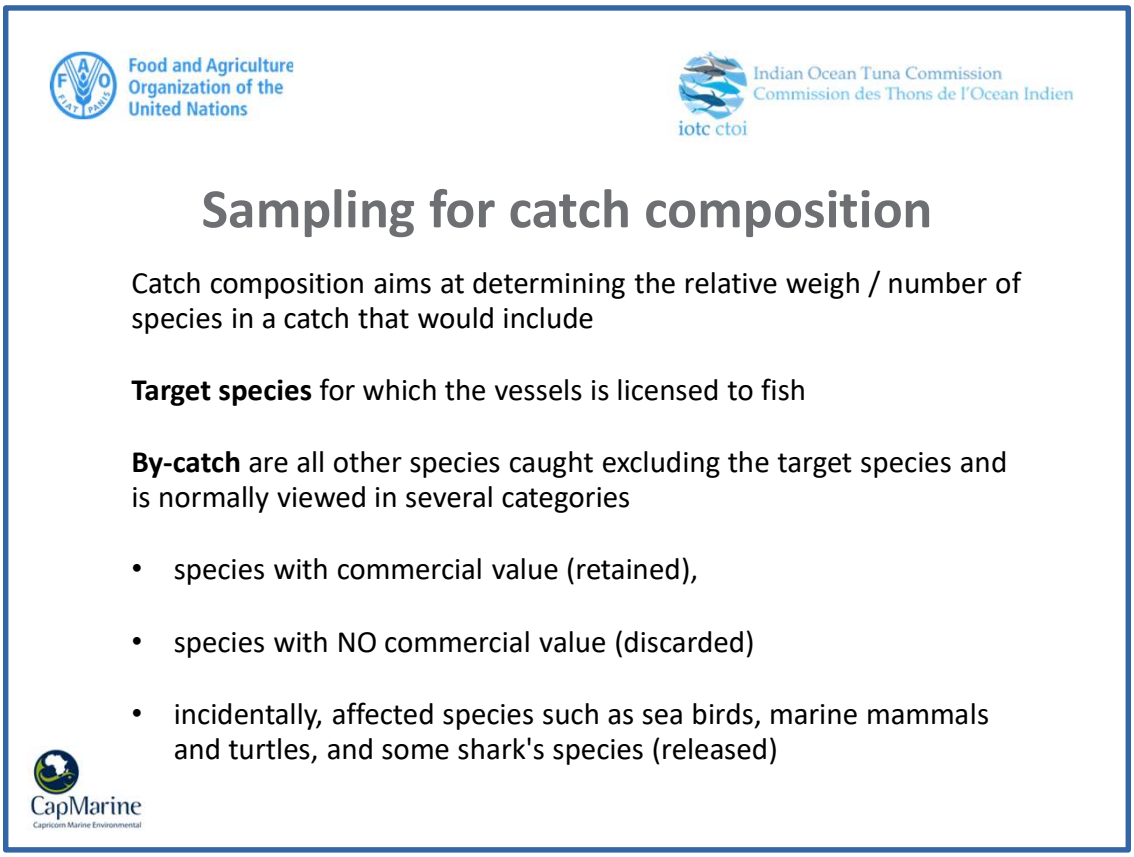
The gear and nature of the longline and gillnet fishing operations are such that the gear is spread out over a large area (up to 30 km for gillnet and up to 200 km for longline).

Catches can show a greater variance in size and species composition over the extended area covered . However, the catch rate over in time is low with a line or net being hauled over a whole day, making it possible to sample up to a 100% of the catch.

Therefore, observers on longliners can record most of the fish and species caught and thereby determine individual fish weights making possible to accurately calculate a total catch weight for both retained and discarded fish.

On a longliner the observer can record each fish and get an estimate the weight from the length or from the crew for processed fish. Note: a conversion factor must be applied to processed fish to get green weigh. (whole weight before processing)

Gillnet vessels tend to catch fish of uniform size and the observer can often count all the fish caught or if catch rates are high sample a high proportion of the net panels hauled.



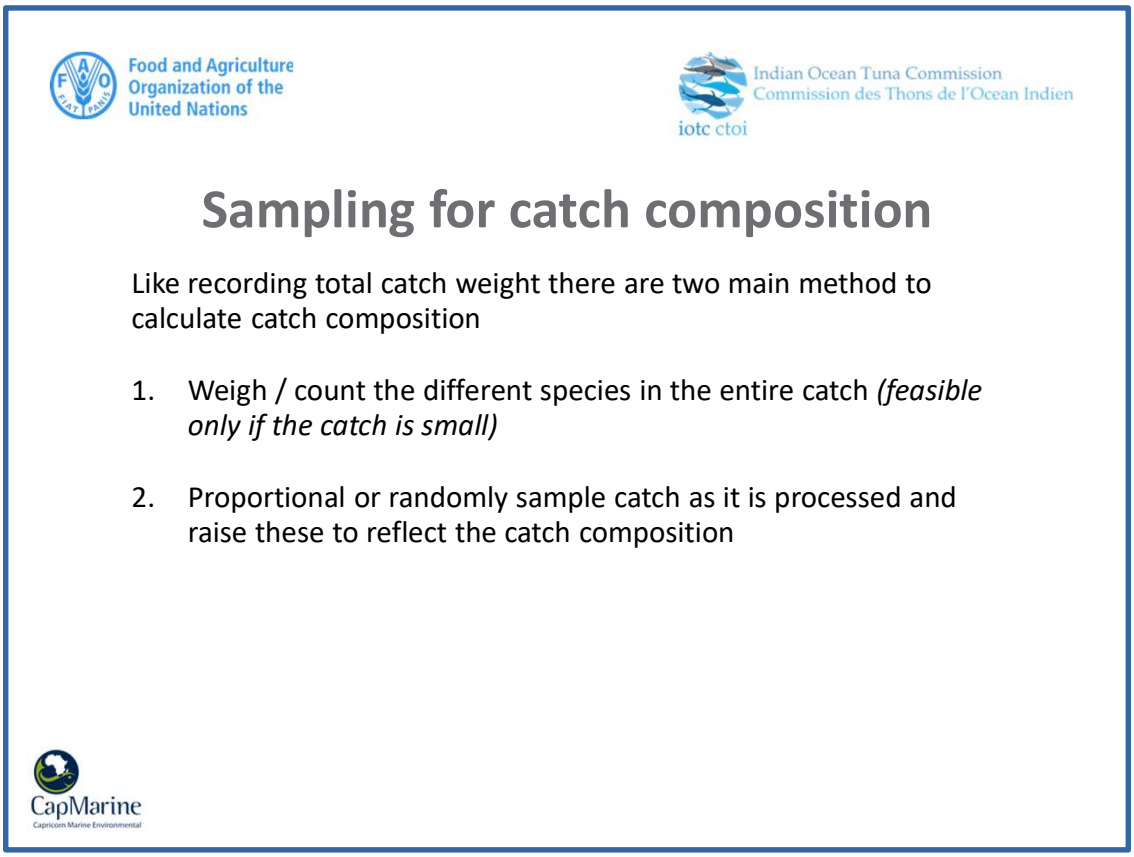
Catch composition aims at determining the relative weigh and or number of the different species in a catch.

The catch is made up of two main components:

- target species, which the vessels is licensed to fish; and
- by-catch, which are all the other species caught excluding the target species.

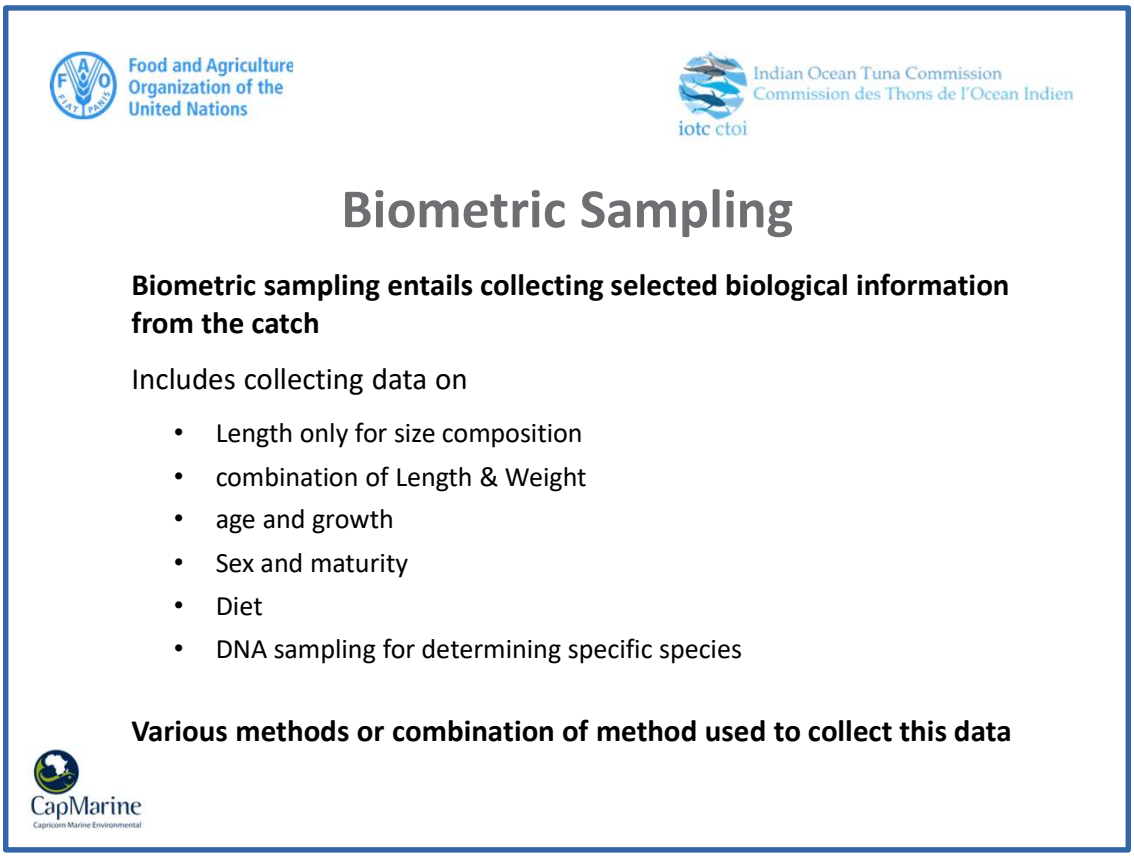
The by-catch can fall into several categories:

- species with commercial value (often also targeted and retained);
- species with NO commercial value (that are discarded often dead); and
- environmentally impacted species such as sea birds, marine mammals and turtles, and some shark's species. *(These are supposed to be released alive where possible and special environments mitigation measures reflected in the IOTC resolutions are sometimes in place that specify the handling of these species and where possible releasing them alive)*



Catch composition aims at determining the relative weigh and or number of the different species in a catch. Like recording total catch weight there are two main methods to meet this requirement:

- weigh and or count all the different species in the entire catch (feasible only if the catch is small); or
- proportionally or randomly sample the catch as it is processed and raise these to reflect the total catch composition.

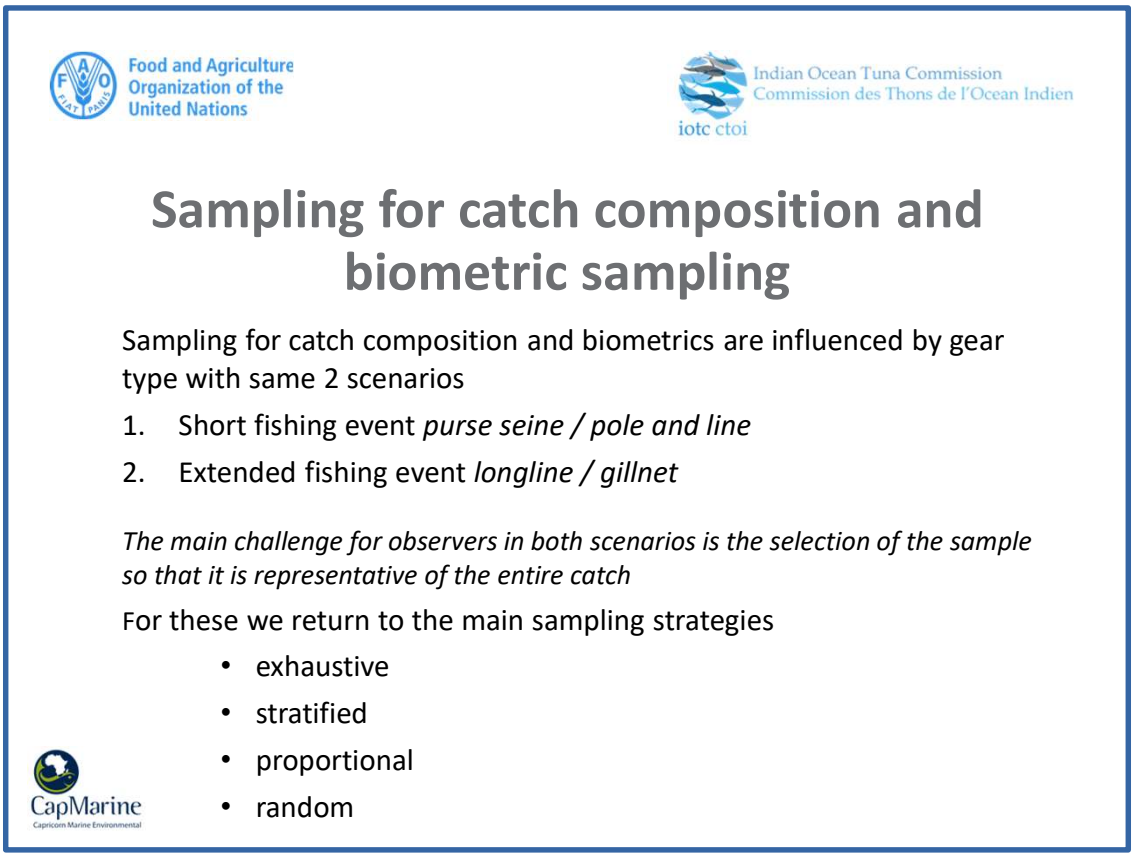


Biometric sampling entails collecting biological information from selected species of the catch. Normally focused on the main target species that are being managed by the IOTC. It can also include species of special interest that are being studied.

Overall biometric sampling (biological sampling) includes collecting data on:

- length for size composition of the catch;
- selected sampling for Length and Weight of individual fish to draw up length/weight regressions;
- otolith or spine sampling to determine age and growth
- sex and maturity of specific species to determine the time and areas that fish spawn;
- determining the diet of the fish by examining stomach contents; and
- collecting DNA samples, often to determine differences between stocks of the same species that may need to be individually managed, for example swordfish found in the Indian Ocean region and the Atlantic Ocean;

Various methods or a combination of method can be used to collect biometric data. Length frequency of the catch will require larger and statistical means to capture the size profile of the entire catch. While measuring length and weigh and collecting other biological data may require fewer and selected samples. *For example; selecting fish of different sizes to weigh and measure to draw up a length-weight regression.*

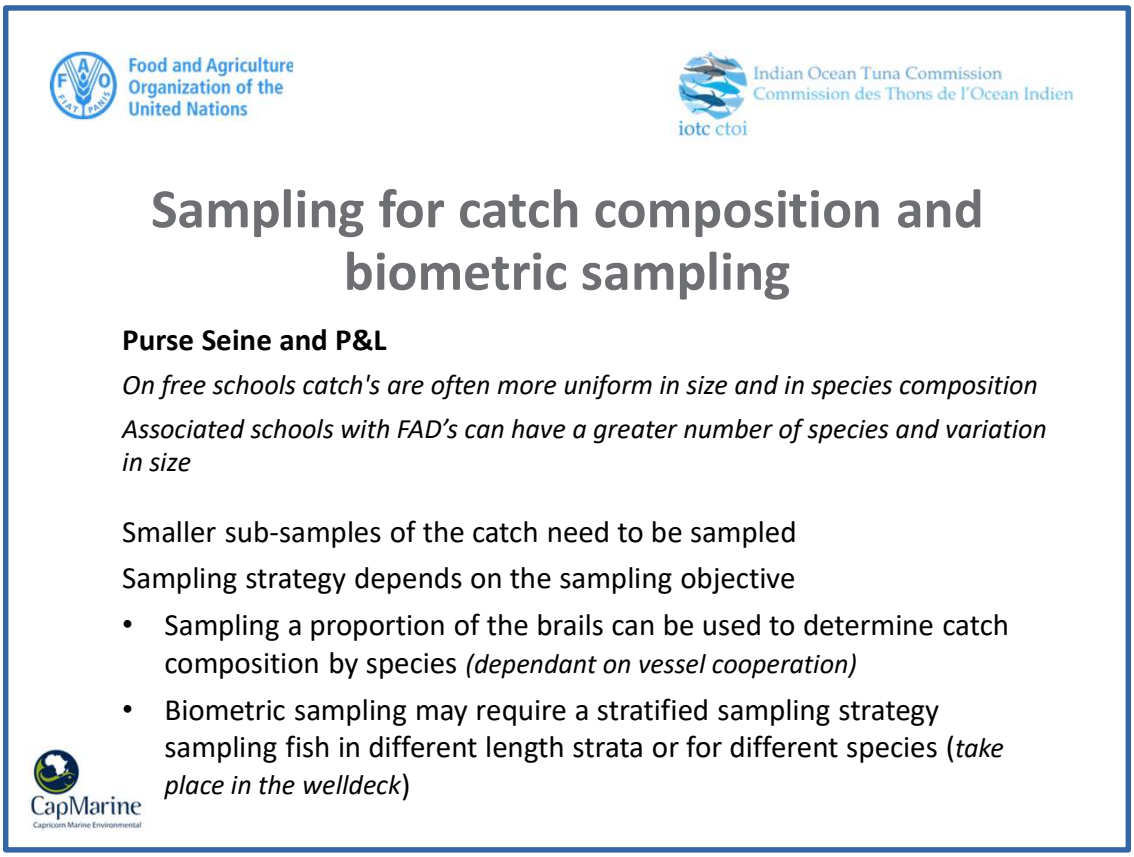


Sampling for catch composition and biometrics is also influenced by the type of gear deployed with same 2 scenarios

1. Short fishing event purse seine / pole and line
2. Extended fishing event longline / gillnet

The main challenge for observers in both scenarios is the selection of the sample so that it is representative of the entire catch. For these we return to the main sampling strategies

- exhaustive
- stratified
- proportional
- random

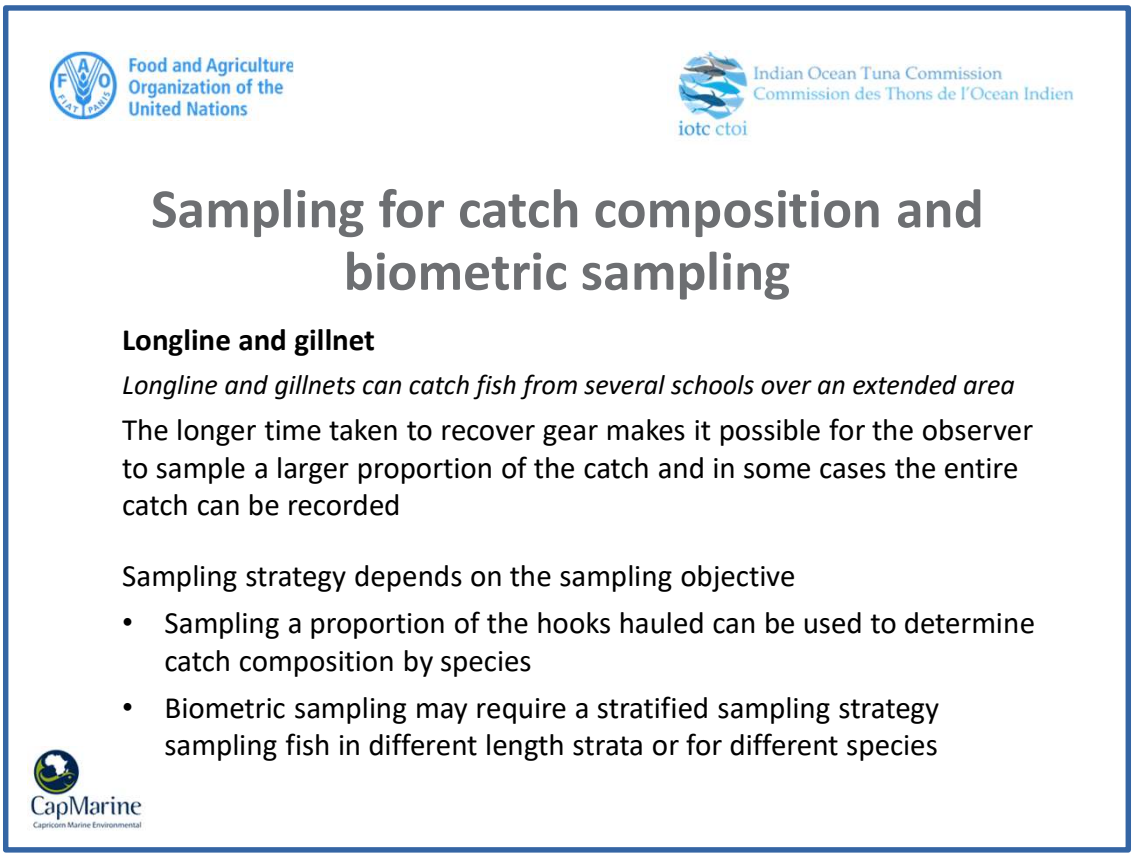


Purse seine and P&L fisheries are surface fisheries that target and catch schooling fish in greater numbers in a short time period. On free schools the catch is often more uniform in size and in species composition. However, for associated schools with FAD's the catch composition can have a greater number of species and variation in size.

Practically, in these situations, only smaller sub-samples of the catch can be sampled. The sampling strategy will depend on the sampling objective.

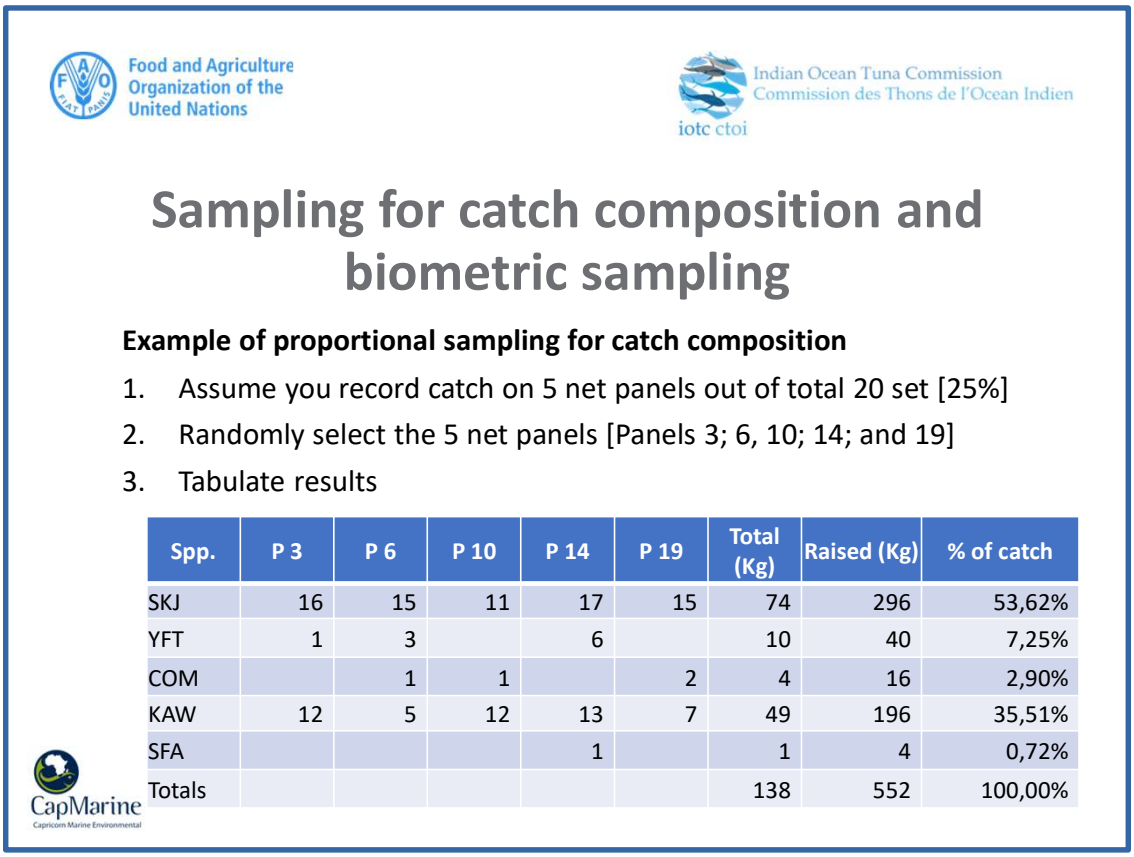
To determine catch composition a proportional sampling strategy can be followed by sampling a proportion of the brails recording the species in each brail and raising this up to a total catch per species. This would require cooperation from the vessel crew.

Biometric sampling may require a stratified sampling strategy by sampling fish in different length strata or for different species. Similar for other biological sampling. This can take place in the welldeck and sampling off the belt.



Longline and gillnets can catch fish from several schools over an extended area. Gillnets, however, tend to catch fish of a more uniform size, while longlines target larger adult species.

Due to the longer time taken to recover these gears it is possible for the observer to sample a larger proportion of the catch and in some cases the entire catch can be recorded. If catch rates are high in places smaller sub-samples of the catch can also be sampled depending on the sampling objective.



Spp.	P 3	P 6	P 10	P 14	P 19	Total (Kg)	Raised (Kg)	% of catch
SKJ	16	15	11	17	15	74	296	53,62%
YFT	1	3		6		10	40	7,25%
COM		1	1		2	4	16	2,90%
KAW	12	5	12	13	7	49	196	35,51%
SFA				1		1	4	0,72%
Totals						138	552	100,00%

Example of proportional sampling for catch composition.

Assume you can record all the catch on 5 net panels on a gillnet vessel that has set a total of 20 net panels. i.e. 25% of the net.

To improve the statistical chance of accurately recording the catch composition over the length of the net you randomly select the 5 net panels out of the 20. For example; Panels 3; 6, 10; 14; and 19. On each panel selected you record the number of each species caught. This can be put into a table. You would then add the number recorded for the 5 panels and raise it to reflect the total catch. Then by dividing the total number of fish recorded and dividing it by the number of each species you would get the relative percentage BY NUMBER of each species caught.

Additional sampling to get an average weight would allow you to calculate the relative weight caught of each species and also the total catch weight.

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